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Mascoma River Greenway Extension

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MASCOMA RIVER GREENWAY EXTENSION

An Independent Project
Submitted to the Faculty
in partial fulfillment of the requirements for the
degree of

Bachelor of Engineering

in

Environmental Engineering

by ISALYS QUINONES

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Approved: _____
Advisor's Signature

_____
Signature of Author

Abstract

In July of 2018, the Mascoma River Greenway (MRG), a 2.2-mile rail trail extending from Downtown Lebanon, NH to Glen Road in West Lebanon, NH, was completed with the help of the MRG Coalition, the Friends of the Northern Rail Trail, Lebanon Recreation and Parks, and members of the City of Lebanon. Initially, this trail was proposed to extend from Downtown Lebanon to Downtown West Lebanon and White River Junction (WRJ). With pushback from the State of New Hampshire to lease the City of Lebanon recreational usage to the New Hampshire State Department of Transportation (NHDOT) owned rail corridor, the project was halted at Glen Road in West Lebanon, NH. In the fall of 2018 and winter of 2019, Group 17: Mascoma River Greenway Extension of ENGS 89/90, came up with the plans to continue to extend the trail by narrowing down different route alignments to one proposed route. This project builds upon Group 17's work, to propose three different options for the final section of the ideal trail alignment that was proposed during their project. Using research of bike lanes in bike-friendly cities, ideas from past similar projects, research on house zoning rights, and field work on the desired area, three route options accommodating bike lanes were evaluated and decided upon. Additional work was also done to gain more community involvement with the MRG. This project suggests three route options to the residential area, from Maple Street through Dana Street, of the final section of the proposed trail alignment from Westboro Yard to the bridge crossing the Connecticut River on Bridge Street.

Preface

This project was done in compensation for ENGS 89 for the Capstone Engineering Design requirement for the Bachelor of Engineering at Dartmouth. At Dartmouth, in order to complete the Bachelor of Engineering, one must complete a two-term course sequence, ENGS 89 and ENGS 90, for the Capstone Engineering Design credit, taken during the fall term and winter term. This two-term course requires groups to tackle a project from an outside company through product design. After missing the first three weeks of school in Fall 2018, due to an amazing opportunity to play in Tenerife, Spain in the FIBA (Federation International Basketball Association) Women's Basketball World Cup for the Puerto Rican National Team, I was not eligible to complete all the requirements for ENGS 89. In those first three weeks of the term, groups form to create the template for how the project will be structured and come up with preliminary ideas regarding the project. At the end of the third week, each group must present their ideas for the project to a review board and write a report about these ideas. After missing this time and work effort, my advisor, Professor Laura Ray, thought it was best that I join a group upon arrival to school, audit ENGS 89 in the fall (which means I would not get course credit), take ENGS 90 in the winter (getting full credit for the course), and complete this independent project in the spring.

Professor Ray and I discussed different options for this project. We both agreed that the project should be based on my group's project in ENGS 89/90. After much collaboration, we both decided that my project should be based on a section of our project that, in ENGS 89/90, we did not completely flush out due to its variety of design options. Therefore, my independent project focused on thorough research of this section, a

presentation of my research to a review board, and this report. This entire project is based on the thoughts put together by my group – ENGS 89/90 Group 17: Mascoma River Greenway Extension.[1]

I would first like to thank Professor Ray for giving me the option of replacing ENGS 89 with this independent project. I understand that the importance of taking time away to support and advise me during this project. I would also like to thank Paul Coats, Director of Recreation and Parks, from the Lebanon Recreation and Parks Department in Lebanon, NH. He has supported me in my endeavors with this project and given me different tasks and people to talk to in order to help get the MRG to completion. Lastly, I would like to thank my friends and family for the constant interest throughout this project and for the future work that I plan to do for the Upper Valley.

Table of Contents

List of Tables and Figures

List of Acronyms

ADA	**Americans with Disabilities Act** – Civil rights law prohibiting discrimination based on disability. ADA standards regulate design, ensuring accessibility of new constructions.
CCRR	**Concord Claremont Railroad** – New Hampshire Railroad Company
ENGS 89/90	**Engineering Design Methodology and Project** – Dartmouth College's engineering culminating experience. This project is completed in compensation for this course.
MRG	**Mascoma River Greenway** – Paved extension of the Northern Rail Trail running from Downtown West Lebanon to Glen Road. The MRG is currently 2.2 miles long and is the center of the proposed two-mile extension.
NHDOT	**New Hampshire Department of Transportation** – State government agency responsible for state-maintained transportation networks. NHDOT supervises the Bureau of Rail Transit, who regulate rail trail developments.
WRJ	**White River Junction** – An unincorporated village in Hartford, VT and the endpoint of the proposed trail extension.

Introduction

Problem Statement & Need

The goal of the MRG is to provide greater connectivity between Downtown Lebanon and West Lebanon, providing safe transportation alternatives and stimulating the local economy.[2] With the completion of the first portion in July of 2018, there is great momentum from the community to see its entire completion to Downtown West Lebanon and White River Junction. In ENGS 89/90, Group 17 was able to provide an ideal route alignment through Downtown West Lebanon. Although this plan did have suggestions in terms of path, the residential area through Maple and Dana Street was not analyzed thoroughly in terms of conductivity on this road and safety of trail users and cars alike. This project helps complete Group 17's project through thorough research on the final alignment section proposed in their project.

Background

In the fall of 2018 and winter of 2019, Group 17: Mascoma River Greenway Extension proposed the final trial alignment for the MRG (see Appendix A). Given different requirements and regulations from their sponsor, Dick Mackay from the Friends of the Northern Rail Trail, they were able to propose an Americans with Disabilities Act (ADA) compliant route from the current terminus at Glen Road to Downtown West Lebanon and White River Junction. The group conducted research of requirements for rail trails in New Hampshire and NHDOT standards. They did field work by surveying users of the trail at a Trail Work Day to see what alignment they would feel the safest using. The group did some engineering analysis in flood mitigation, ramp designs, topographical analysis for ADA accessibility, and economic analysis. They also came up

with alternative alignments in the case that the route they proposed had some drawbacks from the State government.

When deciding on the ideal route, Group 17 broke their entire problem space into three different sections. The first section began at the current terminus in Glen Road and extended to Riverside Park (Figure 1).

Figure 1: Section 1

The second section extended from Riverside Park to Westboro Yard (Figure 2).

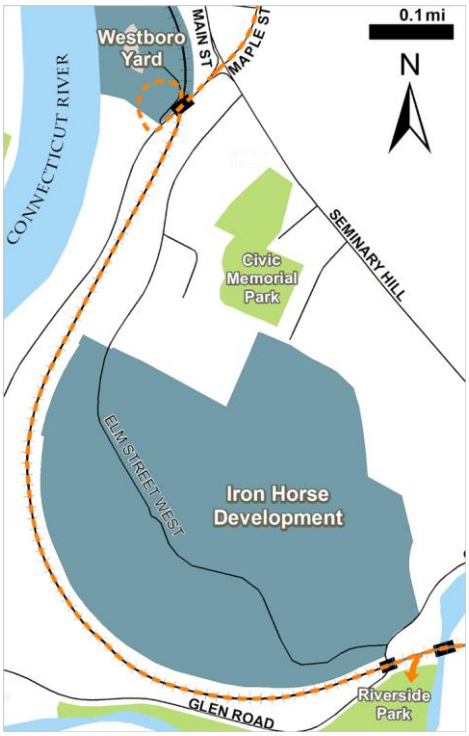


Figure 2: Section 2

The final section extended from Westboro Yard to the bridge across the Connecticut River along Bridge Street that connects Downtown West Lebanon to White River Junction (Figure 3).

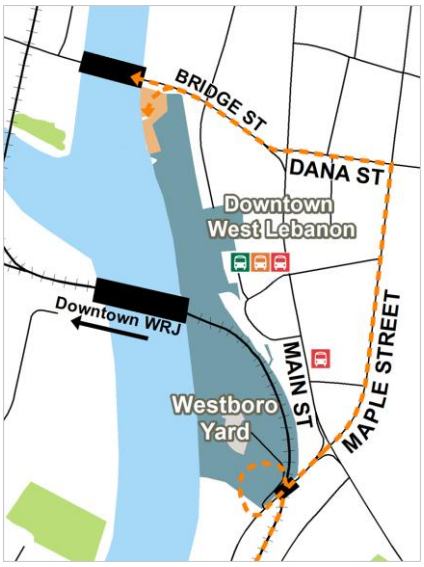


Figure 3: Section 3

This Project

The problem space in this project lies in the third section from Westboro Yard to the Bridge Street bridge (see Figure 4). The alignment route proposed by Group 17 was through a residential neighborhood along Maple Street and Dana Street. This route was suggested because it was considered the safest path, avoiding traffic-heavy streets. The alignment proposed was to follow the already present sidewalks. Due to the limited width of both Maple and Dana Street, there is an inability to add bike lanes on either street. The group suggested a shared roadway design similar to what was completed in Hanover, NH by Alta Planning & Design (see Figure 5). This project seeks to provide three alternatives to the route in this residential area.

Goals for Continuing

Upon completion of their project, Group 17 had some plans for future work that needed to be completed in order to help finish the MRG entirely. First, they had plans to work with a local videographer to create a promotional drone video of the current route to increase public awareness and support for the completion of the MRG. Paul Coats from the Lebanon Recreation and Parks Department advised that the promotional video should be done after the signs along the trail are complete and the trail kiosks are updated.

Secondly, visual assessment of the Mascoma River rail bridges near Riverside Park, revealed that they were structurally sound. The group pushed back plans to conduct a structural integrity assessment, done by engineers from Vanasse Hangen and Brustlin, Inc. (VHB), due to snow and ice limiting bridge accessibility in the winter when this project took place. Despite Group 17's attempt at constant communication with the VHB in the winter, they failed to respond to a number of emails. Additionally, Paul Coats felt that it was not entirely necessary to conduct a structural integrity assessment if the City of Lebanon did not have the rights to this portion of the rail and so could not do anything about the results.

This brings about the third component of future work: negotiating with NHDOT to reclassify the section of rail east of Glen Road to Riverside Park as "inactive". Because the rail is already unused and overgrown, this classification would give the City and the State the ability to come to a rail-banking agreement to potentially use the rail as part of the rail trail, connecting it to Riverside Park, giving it more accessibility and usability.

In order to use the rail-with-trail alignment, Concord Claremont Railroad Company (CCRR) would need to be persuaded to believe that the rail-with-trail

alignment is safe for users. They have expressed concerns about the presence of cyclists and pedestrians near an active rail. In order to combat this reluctance, Group 17 proposed that the City settle on preforming specific risk management strategies with CCRR, to meet their safety standards.

Further negotiations were recommended between the City of Lebanon and NHDOT to lease the Westboro Yard land south of the railyard to the City. After much delay of use in Westboro Yard, this lease would allow for demolition and restoration at the Yard to begin.

Appointment of capital campaign chairs was also recommended to the City to help develop momentum and support for the completion of the MRG, as well as fundraising strategies to push the project forward. In order to strengthen grant applications, the group also suggested collecting data on trail usage by installing electronic counters at several points along the trail in the spring and summer months. This would show potential funding organizations how widely used the trail is and show the importance of completing the trail through White River Junction.

Although these political tasks require much time and persuasion, they are very feasible and necessary for the completion of the ideal trail alignment for the MRG. For the scope of this project, it made sense to apply similar ideas from the ENGS 89/90 project in the terms of route suggestions. For this reason, some work on the side for this project included working with Paul Coats to update trail kiosks and signage along the current MRG; another suggestion Group 17 had for future work. This low-cost improvement to the trail can help gain public support and awareness of the extension project.

Research

To propose final route options for this residential area, research needed to be completed in order to become familiar with the route and different options to propose. The first form of research conducted was finding design inspirations. First, this meant finding diverse bike-friendly cities that accommodate bikes and pedestrians along their roads. The two cities that are focused on in this project are Salt Lake City, Utah and Boulder, Colorado. Aside from looking at cities, inspiration was taken from a similar ENGS 89/90 project done in 2015 called the *Etna Road Expansion*. Finally, research in the form of field work on the site of interest was conducted in order to get familiar with the area, so that appropriate route options could be proposed.

Design Inspirations

Salt Lake City, Utah

Salt Lake City is known for many outdoors activities including cycling. The city is constantly trying to accommodate its people by making the roads accessible by many forms, not just by car. In 2015, 300 Street, known to locals as Broadway, was remodeled to accommodate those traveling by bicycle by adding a raised median (see Appendix B).[3] This remodeling included restriping the roads in order to implement a raised median and creating what they called a "protective sidewalk" (see Appendix B).[4] In order to complete this remodel, who were required to remove the existing parking in front of storefronts to accommodate the bike path users. While there was initial reluctance from the storefront owners, surveys suggest that these new bike paths helped increase sales and a majority of business owners support the bike lanes.[5] Although the "protective sidewalk" is an inventive design, its complexity and location along a road is not related in the scope of

this project. The main takeaway from Salt Lake City was the idea of raised median, and initial pushback from locals that transformed to interest.

Boulder, Colorado

Boulder, Colorado also has many outdoor biking trails. After conducting research, many different types of bike lanes were identified. Appendix C shows three bike lanes that are all on the same plane as the road but differ in the types of barriers that are used. The first figure in Appendix C shows a typical bike lane with one or two white stripes painted along the road to signify the width of the bike lane from the curb. The second figure shows a bike lane with bright green paint throughout the width of the bike lane. This gives more of a visual for both cars and bikers to know the division of the road and the bike lane. The third figure shows the bike lane without paint on the road, but instead concrete parking blocks and delineator posts marking the division.[6] The main takeaway from Boulder was how many different variations of bike lanes are possible and the barriers that they have to separate bikers and cars.

Etna Road Expansion[7]

In 2015, an ENGS 89/90 project was given to Group 6: Etna Road Extension. They were tasked with completing a design for a bicycle and pedestrian path from two separate Hypertherm locations at Etna Road and Great Hollow Road. Through many different design considerations, they decided on expanding the road as opposed to creating a new path or road sharing (see Appendix D). The main reason that they did not recommend a new path is because of the environmental impact that a new path would negatively place on the area. They also found that road sharing was a safety concern, because study found many bike user injuries reported due to road sharing. Secondly, the

group decided against barriers between the road and the bike lane, such as delineator posts, bollards, and a painted spacing. The thought against the delineator posts and the bollards was that the cost for installation and removal each winter would be too high for the project. Research also revelated that these types of barriers actually pose a safety concern for bikers. The group calculated the rate of perceived safety by correlating the change in biking rates for two-way lanes with change in biking rates for one-way lanes. The group found that these types of barriers decreased biker's perception of safety, which they felt would ultimately affect their safety and usability of the path. This project showed the different types of barriers that are possible for a low-cost project, such as this project, and the reasoning behind some uses of barriers versus others.

Design Inspiration Conclusions

Overall, the research done for this project showed the different types of barriers that are used in bike lanes in bike-friendly cities. Upon further research, it was found that there are several different types of barriers used for bike lanes. These include delineator posts, bollards, concrete barriers, raised medians, raised lanes, planters, concrete parking blocks and parked cars (see Appendix E).[8] Delineator posts, bollards, concrete barriers, and parking spots were the most common physical barriers for bike lanes found in this research; while painted barriers were also very common.

Field Work

On a May 24, 2019, field work was conducted to get familiar with the area of interest. In order to get an idea of how wide the road and sidewalk currently are, measurements were taken along many points of the roads. Each measurement is facing north and includes the sidewalks themselves, grass barriers, and gutters. The width of

Maple Street on the right side ranged from 68 inches to 172 inches with an average width of 125.25 inches. On the left side, the width ranged from 55 inches to 83 inches with an average width of 70 inches. Along Dana Street, the width of the left side was about 157 inches. The right side was approximately 102 inches, taking a steep inclined slope into consideration (see Appendix F). This data shows that if the road was rebuilt to accommodate the extension, it would be ADA compliant with a minimum width of 36 inches.[9] Due to safety concerns, the width of the road itself was merely approximated to be around 20 feet.

On the same day, Friday May 24th, from 1:25pm to 2:25pm, additional data was collected regarding the number of vehicles and pedestrians that passed a spot located towards the center of Maple Street. The table below shows the different types of transportation that passed this point in this hour.

Transportation Type	**Amount**
Car	126
Truck	35
Bus	10
Motorcycle	1
Walker	16
Bicycle	2
Total (vehicles)	172
Total (pedestrians)	18

Table 1: Different Types of Transportation

This data shows that what was initially thought of as a low-use residential road, is actually a highly used road with several types of transportation. It is important to note that this was Memorial Day weekend so this data attempts to show when people would be using this route more frequently because of the holiday weekend. It is also important to note that the sidewalk does not run on both sides of the road at all times. This poses a

threat to different legal issues that might be encountered when trying to shift the roads to accommodate an extra lane.

Route Development

ENGS 89/90 Project Space

In ENGS 89/90, the problem space tackled by Group 17 was from the current terminus of the MRG to White River Junction. As mentioned above, the group broke the route into three sections to simplify the final route decision. The first section includes the current terminus of the MRG to Riverside Park pictured in Figure 1 above. The second section extends from Riverside Park to Westboro Yard pictured in Figure 2. The final section extends from Westboro Yard to the proposed terminus at the Bridge Street bridge shown in Figure 3.

This Project's Problem Space

This project is focused on the residential road in Section 3 beginning after the intersection onto Maple Street and just before the Dana and Bridge Street intersection (Figure 4).

Figure 4: This Project's Problem Space

Route Option #1: Prior Alignment

The first route option proposed in this project is the previous alignment that Group 17 proposed. They recommended that Maple Street be a road sharing street. This would mean that Maple Street would need to be restriped to prioritize safe pedestrian and bicycle travel. This option would force cars to share a center lane while pedestrians or bikes were present. The idea for this plan came from a design completed by Alta Planning and Design in Hanover, New Hampshire, a couple miles north of the problem space (see Figure 5 and Appendix G).[10]

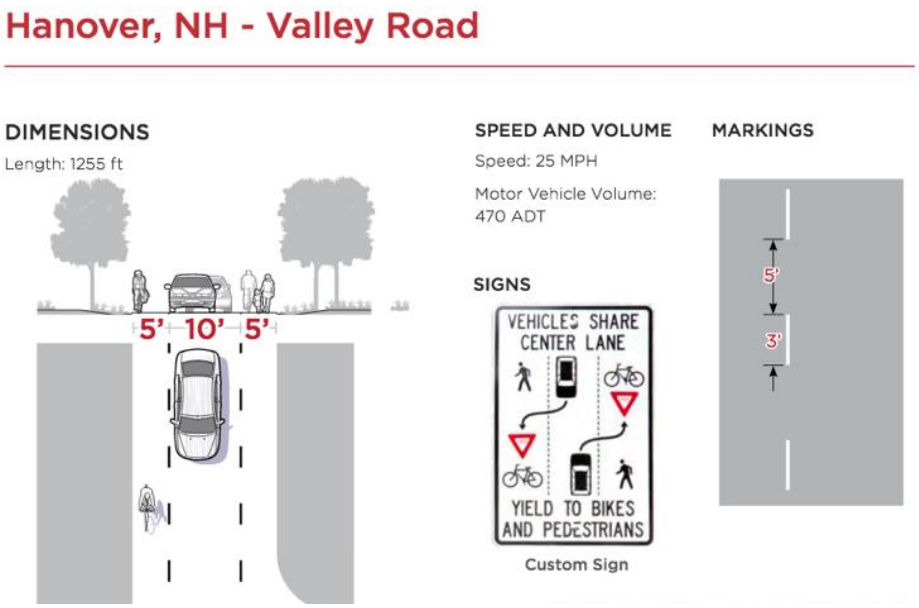


Figure 5: Route Option #1

The proposed route option would implement this same idea but include for a 12-foot-wide center lane to allow fire trucks to safely use this road in an emergency. The Lebanon Fire Department has raised concerns about bike lanes around the city and requires a 12-foot minimum lane to avoid crossing over any lanes.[11] Moreover, the Federal Emergency Management Agency suggests that when constructing a road, there should be a minimum width of 20 feet for access roads and 12 feet for driveways to allow

evacuation and emergency vehicles simultaneous access.[12] This route option would remove one foot from each bike lane pictured, leaving 4 feet for the bike lanes and the required 12 feet for the emergency vehicles. This would still leave enough ADA compliant space for the pedestrians and accommodate the safe travel of emergency vehicles.

This option, although cost effective and easily implementable, does bring on some safety concerns for the trail users and cars using the roads. Section 265:143 in the Laws Applicable to Motor Vehicle and Bicycle Operation Manual from NHDOT says that all bicycles are liable to vehicle laws when in the bike lane[13], raising some safety concerns for young trail users. However, Section 265:143-a from the same manual states that when a vehicle desires to pass a bicyclist, "at least 3 feet of distance from the cyclist is required when the vehicle is traveling at 30 miles per hour or less, with one additional foot of clearance required for every 10 miles per hour above 30 miles per hour."[14] Because this is already a low speed road (30 miles per hour according to the New Hampshire Division of Motor Vehicles),[15] this rule is already in place. Furthermore, Section 265:144-X. states that "no person less than 16 years of age may operate or ride upon a bicycle on a public way unless he or she wears protective headgear of a type approved by the commissioner of health and human services."[16] This would help alleviate the concern of the safety for small children using this proposed bike option.

Route Option #2: Even Plane

The second route option would be to completely remodel the roads, demolishing existing sidewalks, and make the trail on one even plane - the same height as the road (see Figure 6 and Appendix H). Previous barriers mentioned could be used to distinguish

the bike lane and the road, however, these barriers are not required. Alta Planning and Design suggests that "by separating bicyclists from motor traffic, "protected" or physically separated bike lanes can offer a higher level of comfort than conventional bike lanes and are attractive to a wider spectrum of the public."[17]

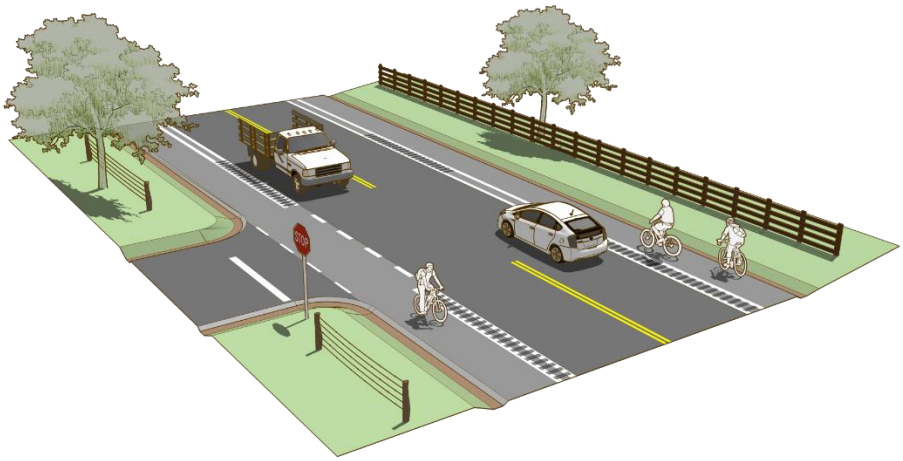


Figure 6: Route Option #2

Plus, the Construction Requirements Section of the 2016 NHDOT Standard Specifications does not state that a sidewalk is required to be raised,[18] allowing this to be a viable option. After review of the Etna Road Expansion project, it appears that barriers actually decrease the safety of the bicyclists because of their inability to move quickly out of danger that may be on the path, such as branches or a sudden stop from a cyclist ahead. Moreover, by putting up barriers, the parking along the road is decreased, a necessity for a residential area. Furthermore, the initial cost of implementation and the reoccurring costs to remove barriers in the wintertime, is the main reason that the Etna Road Expansion group suggested against the use of physical barriers. This route option tackles the safety concerns of the previous route option by giving ADA compliance to pedestrians by designating room to both the vehicles and the pedestrians.

Route Option #3: Raised Sidewalk

The third route option would be to remodel the roads entirely, as the previous option, but to add raised sidewalks to both sides of the road (Figure 7).

Figure 7: Route Option #3[19]

This option would ensure comfort for trail users and vehicles alike by placing enough space for people to travel by car, bike, or on foot. This route would also accomplish ADA compliance on the raised sidewalks and obtain a width of 12-foot-wide two-way traffic for vehicles. On the other hand, the costs to implement this idea would be the highest of all three route options due to an increase of materials needed. Plus, there are apparent legal constraints that hinder the completion of this route option.

According to "A Hard Road to Travel: New Hampshire Law of Local Highways, Streets and Trails," the Minimum Road Access Requirements Under State Law Document states that the relevant construction standards of streets and driveways are whatever standards the Planning Board decides to impose.[20] The Zoning Ordinance in Lebanon, NH, classifies all buildings along either side of Dana and Maple Street are under the R-3 District.[21] Section 302.1-302.2 and Section 501.2 state that those

requesting permitted uses of Use Districts, including the R-3 District, are required to obtain a Conditional Use Permit from the Planning Board or special exception from the Zoning Board of Adjustment.[22] While special exceptions can only be issued by the Zoning Board of Adjustment under RSA 674:33, Section IV, conditional use permits may be issued by any municipal board which has been given authority under the zoning ordinance, RSA 674:21, Section II.[23]

This means that in order for there to be any changes made to the land along Dana or Maple Street, there needs to be a permit accepted by the landowner and by either department. Written approval from those whose property lies on the portion of the proposed public recreation use project is required.[24] In order to apply the changes, a public hearing at City Council would need to take place.[25] All these legal issues make this option, while not impossible, very difficult.

Additional Work

Some work that I completed aside from the research and designing requirements for this project focused on Paul Coats's ideas about the importance of engaging the community in the extension plans for the MRG. On April 28, 2019, I met with Alex Bernhard, the Vice President of Friends on the Northern Rail Trail, to discuss ways in which to help the Northern Rail Trail get community involvement with the MRG. The Northern Rail Trail is a 58-mile-long rail trail that connects Boscawen, NH to Lebanon, NH. Because the terminus of Northern Rail Trail is in Downtown Lebanon, by connecting people who frequently use the Northern Rail Trail to the MRG, more community support can be gained to see the completion of the MRG to White River

Junction. I will be working with Alex this summer (2019) to help with the improvement of trail kiosks along the Northern Rail Trail.

The second form of work was to participate in the Lebanon Community Clean Up Day on Saturday, May 4, 2019 (see Appendix I). I was tasked with standing behind a table in front of the Kilton Public Library with a map, trash bags, gloves, and different breakfast items to encourage the community to clean up trash as they walked around town. After standing outside for 2 hours that morning, I was able to get more than 15 people to grab over 35 trash bags to help clean the community. Although distant from the current terminus of the MRG, the primary goal of this task was to get people to clean up the community wherever they could go. Because my table was posted in front of a public library, I was also able to make people going to the library aware of the current MRG.

Lastly, I met with Paul Coats on May 8, 2019, to discuss different points along the MRG where we needed to place wayfinding signs. My contribution was a "non-local" perspective on what information should be on the signs and how to structurally place the signs so that they do not wear over time to the point of collapse. On May 15th, we biked along the MRG to confirm the placements that we came up with for the signs (see Appendix I). I will also work with Paul this summer and fall (2019) to finish the improvements to the wayfinding signs and trail kiosks along the MRG.

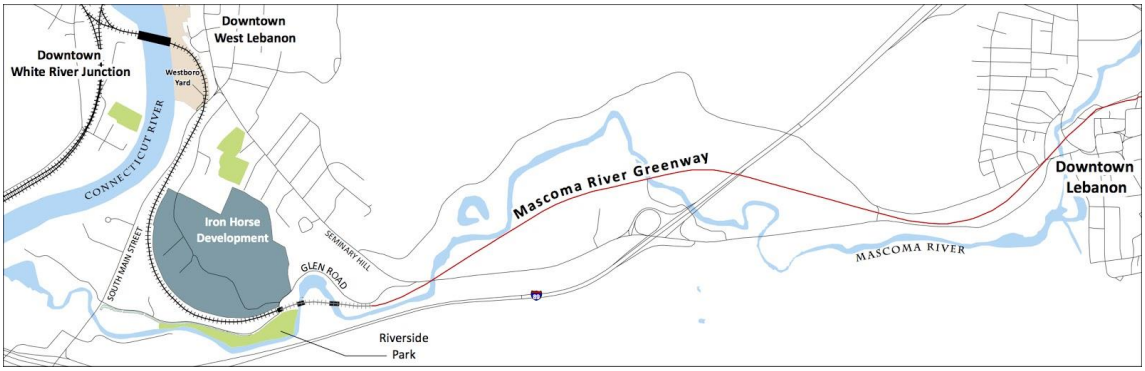
Future Work

In terms of future work for the MRG extension, the first order of business is updating and adding the trail kiosks and signs along the MRG, as explained in the Additional Work section. Secondly, it is important to collect data on the traffic of the residential area at peak hours of the day. This information will help decide on the proper

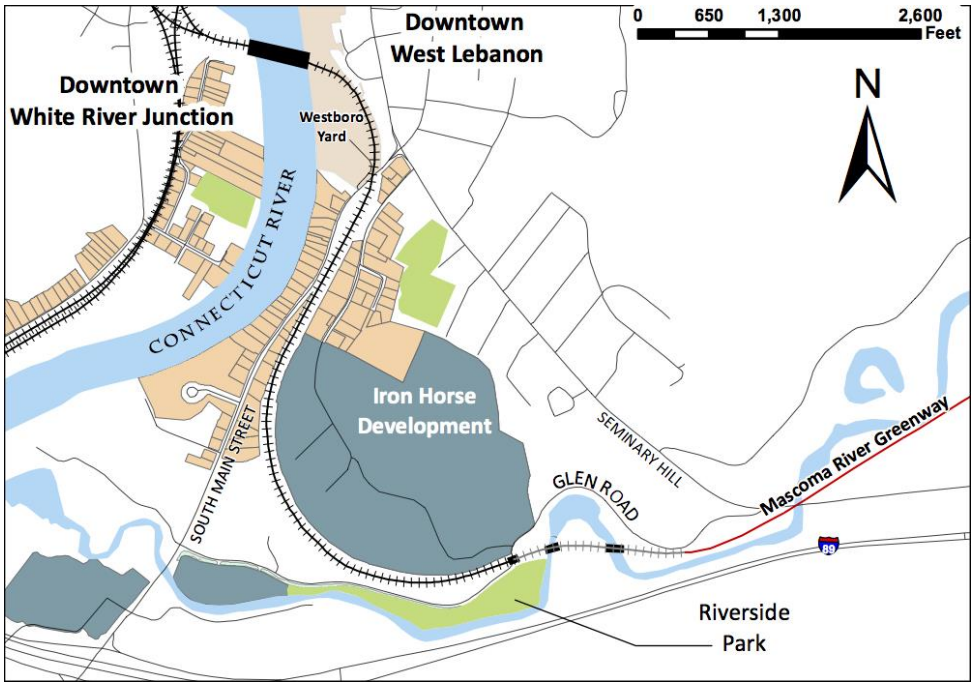
route option to ensure the safety of trail users and vehicles. It will also help the future trail users to know when not to use the trail, in order to avoid heavy traffic. The following future tasks are the same tasks as explained in the Goals for Continuing section in the Introduction portion of this project. The more tangible future tasks include a promotional video once the trail signs and kiosk are fixed and collecting data of the current MRG usage. The works that follow are political tasks such as negotiations with NHDOT and CCRR, petitioning to reclassify the overgrown rail as inactive, and appointing capital campaign chairs. Once all this is complete, bridge assessment of the two rail bridges by Riverside Park can take place and the MRG extension can begin to take shape.

Appendices

Appendix A-Background



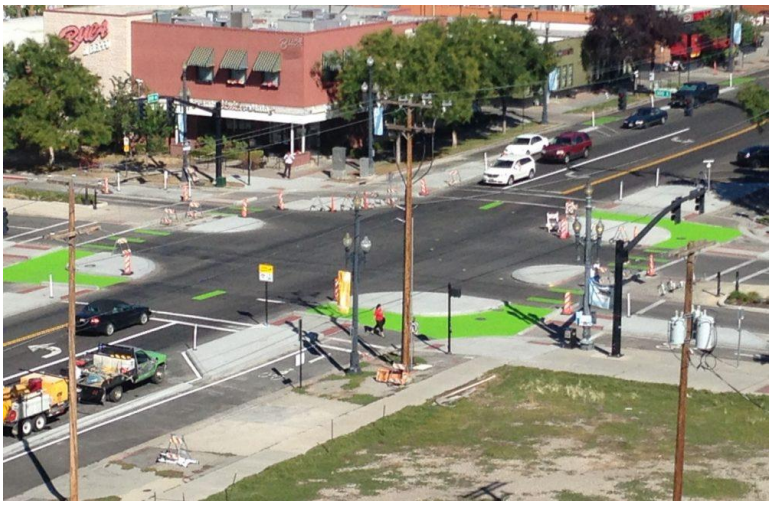
Mascoma River Greenway and Group 17 Project Space



Group 17 Project Space

Appendix B-Salt Lake City, Utah

Raised Median



Protective Sidewalk

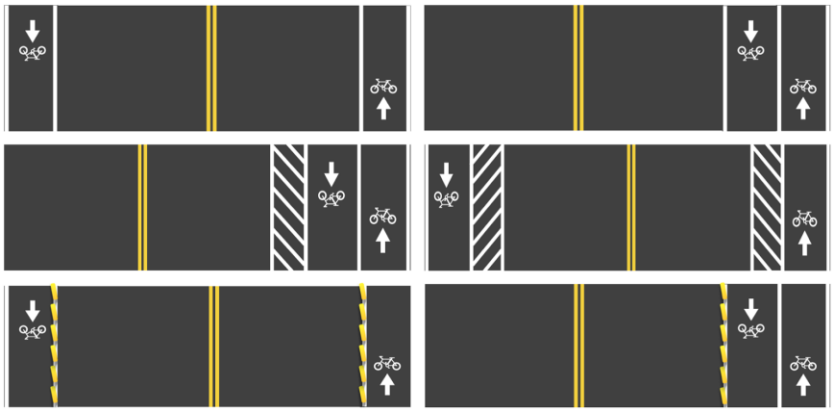
Appendix C-Boulder, Colorado

Striped Lane

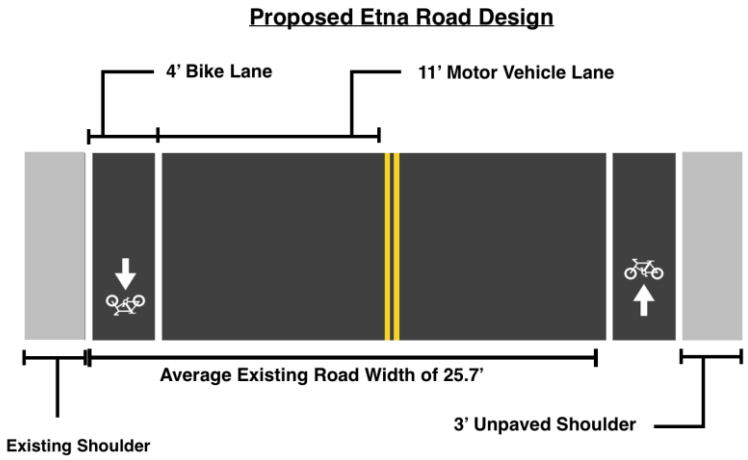
Painted Lane

Concrete Parking Blocks

Appendix D-Etna Road Expansion



Etna Road Expansion Design Considerations



Etna Road Final Road Design

Etna Road Expansion Notes

Design decisions

- New Path
- Road Expansion
- Road Share
    - Construction costs
    - Other costs
    - Environmental impact
    - Safety improvement

Bike Lane Alternatives

- No buffer one-way bike lanes
- No buffer two-way bike lanes
- Painted buffer one way
- Painted buffer two way
- Plastic bollards one way
- Plastic bollards two way
    - Cost
    - Disturbed land
    - Perception of safety
    - Winter safety
    - Intersection safety

Bike safety alternatives

- Bike lane
- Unmarked buffer
- Wide curb lane
    - Car/bike distance
    - Bike/road edge distance
    - Lane encroachment while passing
    - Bicyclist path spread

Pedestrian path

- Paved path
- Sidewalk
- Gravel path
- No path
    - Construction costs
    - Maintenance cost
    - Accident rate
    - Pavement impact

Road expansion vs Sharing

- Road expansion
- Road sharing
    - Costs
    - Disturbed land
    - Fatal crash types
    - Injury frequency
    - Perception of safety

Appendix E-Design Inspiration Conclusions

Delineator Posts

Bollards

Concrete Barriers

Raised Median

Raised Lane

Planters

Concrete Parking Blocks

Parked Cars

Appendix F-Field Work

The following pictures are consecutively going north along Maple Street.

The following picture is facing west along Dana Street.

<u>Measurements for Sidewalk</u>

All directions are going north**

All measurements are in inches**

Main Street/Seminary Hill Road and Maple Street (right)

- Paved: 74 in
- Edge of sidewalk: 5 in
- Total: 79 in = 6 feet and 7 inches

Maple Street and Orcutt Avenue (right)

- Paved: 63 in
- Not paved: 56 in
- Edge of sidewalk: 5 in
- Total: 124 in = 10 feet and 4 inches

In front of West Lebanon Congregational Church (right)

- Paved: 63 in
- Edge of sidewalk: 5 in
- Total: 68 in = 5 feet and 8 inches

Maple Street and Pleasant Street (right)

- Paved: 55 in
- Not paved: 66 in
- Total: 121 in = 10 feet and 1 inch

**sidewalk starts on the left side

Maple Street and Pleasant Street (left)

- Paved: 55 in
- Gutter: 28 in
- Total: 83 in = 6 feet and 11 inches

Before Speed Table (right)

- Paved: 60 in
- Not paved: 86 in
- Total: 146 in = 12 feet and 2 inches

After Speed Table (right)

- Paved: 56 in
- Not paved: 116 in
- Total: 172 in = 14 feet and 4 inches

Before Maple Street and Tracy Street (left)

- Paved: 48 in
- Cracked paved: 24 in
- Total: 72 in = 6 feet

After Maple Street and Tracy Street (right)

- Paved: 53 in
- Not paved: 57 in
- Total: 110 in = 9 feet and 2 inches

Before Cross Sign at Olivet Baptist Church (right)

- Paved: 57 in
- Not paved: 125 in
- Total: 182 in = 15 feet and 2 inches

After Cross Sign at Olivet Baptist Church (left) – unpaved is gone

- Paved: 55 in = 4 feet and 7 inches

Dana Street (left)

- Paved: 60 in
- Not paved: 97 in
- Total: 157 in = 13 feet and 1 inch

Dana Street (right) – there is a grade

- Paved: 62 in
- Unpaved: Hypotenuse = 58 in, Height = 3.5 feet
    - Total: about 40 in
- Total: 102 in = 8 feet and 6 inches

Appendix G-Final Option #1

Alta Planning + Design Road Design in Hanover, NH

Appendix H-Final Option #2

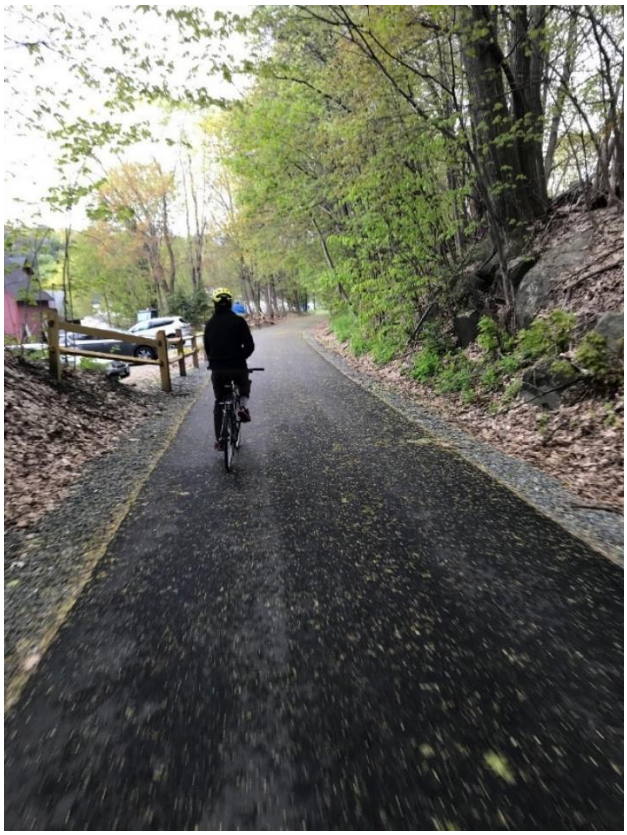
Even Plane with Barriers[26]

Even Plane Without Barriers[27]

Appendix I-Additional Work

Community Clean Up Day

Table at Community Clean Up Day



Biking Along the MRG to See Where to Place Signage

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